Williams Electronics, Inc

Defender Servicing

Power Supply and Interface Board

Recap Sheet

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This recap sheet covers troubleshooting the power supply and interface board for the Defender Video Game. This sheet contains the most important points covered in the accompanying video tape. Use this recap sheet in conjunction with your Defender schematic diagrams to assist you later on in recalling information as you need it while performing your work.

Since the power supply is one of the most important boards in any piece of equipment, the video started there. The Defender power supply provides the voltages necessary for proper game operation. Because of this, when checking any malfunction in the system, you should always check the operating voltages first.

The power supply provides regulated D.C. outputs of plus 5, minus 5, and plus 12 volts. It also supplies unregulated D.C. outputs of plus 12, minus 12, and plus 27 volts.

An additional A.C. output of 6.3 volts is also provided to power lamps used for general illumination.

Following the power distribution shematic ypu can see that the plus 5 volts regulated DC feeds the CPU Video board, the ROM board, and the Sound board.

The minus 5 volts regulated DC feeds the CPU Video board.

The plus 12 volts regulated DC feeds the CPU Video board.

The plus 12 volts unregulated DC feeds the CPU Video board, the Sound board, and the coin door.

The minus 12 volts unregulated DC feeds the Sound board.

And finally, the 27 volts unregulated DC feeds the coin door lockout.

Next, the video took a look at the power supply board itself. There are three main sections to the power supply. These three sections generate all of the voltages discussed.

The first section generates the plus 5 volt regulated and the plus and minus 12 volt unregulated supplies. The main power transformer provides this circuit with 9.7 volts AC. The tolerance on this voltage is plus 10 percent and minus 15 percent. The 9.7 volts AC is rectified by bridge BR1. This provides two outputs. One is the plus 12.8 volts DC shown at test point two. This voltage is used to supply both the plus and minus 12 volt unregulated supplies as well as the plus 5 volt supply.

Therefore test point two is critical, remember to check the voltage at this point when troubleshooting.

Another important part of this circuit is filter capacitor C12. If this capacitor is leaky it can be the cause of low unregulated voltages.

The second output from the bridge goes to a doubler made up of diodes D2 and D3. The output of the doubler is the supply voltage for the power supply regulator, IC1.

This regulator is the heart of the plus 5 volt regulated circuit. If you suspect problems with this supply check pin 10, which is the output of the regulator. A low voltage here will cause the 5 volt circuit to be low.

While checking out the regulator, you should also check pin 5 which provides the reference voltage. This voltage should be between 4.75 and 5.25 volts DC.

Finally, there is diode L.E.D. 1. When this diode and other diodes like it in the power supply are lit, it is an indication of the presence of the particular supply. It does not mean that the voltage is correct. It only means that there is enough voltage to light the diode. Do not mistake a lighted diode to mean that the supply is operating properly. If you suspect a problem...measure the voltage.

The next section of the power supply provides the plus 12 volt regulated and plus 27 volt unregulated sources. The tolerance on the 12 volt regulated source is plus or minus 5 percent.

The main power transformer provides this circuit with 20.9 volts AC. This voltage is rectified by bridge B.R. 2. The output of the rectifier provides the unregulated 27 volts DC as well as the operating voltage for regulator I.C. 2.

As in the previous circuit the output of the regulator is pin 10, and the reference voltage is pin 5. If you are experiencing a low 12 volts regulated, check to see that the output voltage at pin 10 is correct. A low voltage here will cause the low operating voltage.

Once again the L.E.D. for this section of the power supply is an indication only of the presence of voltage. It does not mean that the voltage is at the proper level.

The final section of the power supply provides the minus 5 volts regulated and the 6.3 volts AC. Once again this circuit receives its input from the main transformer. This 9.1 volt AC input is rectified by bridge B.R.3.

The output of the bridge is regulated by Q 2. The regulator output can be checked at test point 5.

The 6.3 volts AC is taken directly from the AC input voltage and dropped to the proper level by resistor R 15. It is important to note that if this circuit shorts to ground it can affect the operation of the minus five volt supply. This is because any short in this circuit will lower the input voltage to the rectified, lowering the 5 volt output.

Be certain to check this possibility if there are problems with the minus five volt supply. And as before the operation of the L.E.D. in this circuit is an indication of the presence of voltage, not the level of that voltage.

When troubleshooting the Defender Video Game it is important to remember to always check the power supply voltages first.

Even though the ROM or RAM diagnostics may indicate a failure, the failure may be a result of a low operating voltage. Changing the ROM board and then finding out that you still have the same problem can be a time consuming as well as expensive mistake.

You can quickly isolate any potential power supply problem by first noting which board or boards are malfunctioning and determining the power sources to that board.

Next, go to that section or sections of the power supply and check the L.E.D.'s. If the L.E.D. is not lit, it is an indication of no voltage at that supply. If the L.E.D. is lit, it means only that a voltage is present at that supply.

You must then check the level of the voltage. Do this using a voltmeter. For the 5 volt regulated supply, check the voltage at test point one. It should read plus 4.75 to 5.25 volts DC.

If this voltage is improper, check the output of regulator I.C.1. This should read approximately plus 6.7 volts DC. Continue this procedure of checking backwards through the circuit until you have isolated the faulty component or components. The normal operating voltages that should be present are indicated on the schematic diagram for the power supply.

For the plus 12 volt unregulated supply, check the voltage at test point 2. If this voltage is low, check filter capacitor C12. This could be leaky, resulting in a low voltage at this point.

For the plus 12 volt regulated supply, check test point 4. If the voltage here is low, check the operating voltages associated with regulator I.C.2. Use the same techniques for checking this supply as with the plus 5 volt supply.

For the minus 5 volt supply, check test point 5. If this voltage is low, check the operating voltages for regulator Q2. Also, remember in this circuit that a shorted 6.3 volt AC supply can affect the output of the bridge for the minus 5 volt supply.

Using these basic troubleshooting techniques should enable you to diagnose any problems associated with the Defender power supply board.

The next section the video tape dealt with was the Interface Board. The Interface Board provides a means of connecting the Player Control Panel to the CPU Video Board.

The control panel switches are held high at 5 volts. When hit, the switches go to ground.

This change in voltage level is feed through the appropriate HEX Inverter...Through the multiplexer IC's...To the PIA (IC 1).

The outputs of the PIA are routed to the appropriate input on the CPU Video Board.

Control of the PIA is accomplished through the CPU Video Board.

Prior to troubleshooting the interface board you should first run the switch diagnostics. If the diagnostics indicate a failure, you can suspect either a switch or interface board problem.

The first thing to always check on the interface board is the jumpering. The jumpering criteria is noted on the schematic diagram. Depending on the type of console, jumpering changes. Improper jumpering can cause the game to appear to malfunction.

Assuming that the jumpering is okay check the operation of the suspect switch by measuring the voltage at the appropriate input pin on the interface board. With the voltmeter probe still on the pin, press the switch.

The voltage should drop from 5 volts to zero. If the voltage is less than 5 volts, and the power supply is operating properly, check the pull-up resistors in IC 5.

Also check the one "k" protection resistors.

If the voltage is okay and it goes to ground when the switch is pressed, check the HEX Inverters.

The input to the inverters should normally be between 3.5 and 5 volts, and the output at zero. When the switches are pressed, the output of the inverters should go to five volts.

If a bad HEX Inverter is suspected, prior to replacing the inverter IC, check capacitors C2, C3, and C4. A faulty capacitor here can affect the operation of the HEX Inverters.

Experience has shown that the multiplexers and PIA are seldom bad.

You should be able to localize any problems on the interface board by the time you reach the HEX inverters.

With few exceptions, following the guidelines presented here should aid you in troubleshooting the power supply and interface boards.

A few key points to remember are...Always check the power supply first...

The power supply LED'S are an indication of the presence of a voltage, not the level of that voltage...

If everything else is okay, but the game doesn't play, check the player switches, then check the interface board...

Check for proper jumpering on the interface board.

This concluded the video tape.